

HOT WINDS AT TAMPICO, MEXICO, APRIL 6 AND 7, 1919.

By S. A. GROGAN.

[Dated: Mexican Gulf Oil Co., Tampico, Mexico, Apr. 15, 1919.]

On April 6, 1919, we had a hot, dry southwest wind from 11 a. m. to 3 p. m. (Tampico time) with a maximum temperature, 93.5° F., the highest since June 19, 1918. On April 7, from 11 a. m. to 1:15 p. m., the hot wind blew again, with a maximum temperature of 99° F. at 1:15 p. m., when the wind changed to SE., and there was a drop of 16° in five minutes. This maximum temperature is the highest on our record, which dates from October 12, 1917. Figure 1 shows tracings from the thermograph record, corrected to the thermometer readings, and from the barograph here, April 5 to 9, 1919. Table 1 gives in detail the observations made on April 7.

TABLE 1.—Weather Observations, Tampico, Mexico, April 7, 1919.

Observation of—	Tampico time.		
	6.30 a. m.	12.15 p. m.	6.30 p. m.
Dry thermometer	71.5° F.	96° F.	77° F.
Wet thermometer	69.5° F.	67.5° F.	72° F.
Dewpoint	68° F.	49.5° F.	70.5° F.
Relative humidity	30 per cent.	21 per cent.	79 per cent.
Vapor pressure	0.684 inch.	0.353 inch.	0.732 inch.
Barometer	29.71 inches.	29.71 inches.	29.69 inches.
State of weather	clear.	clear.	cloudy.
Wind blowing from	S.	SW.	SE.

the opinion that the warmth and dryness of the wind could not have been caused by having blown over hot and dry land. The Sierra Madre mountains [eastern escarpment of the plateau] are 60 miles west of Tampico.

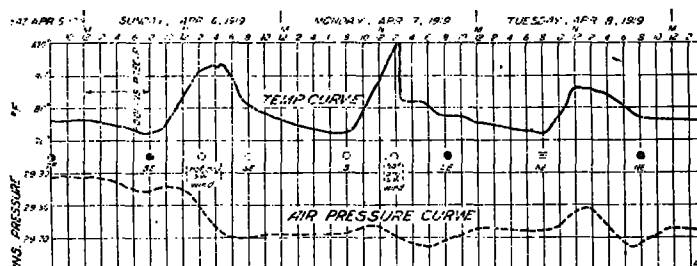


FIG. 1.—Weather at Tampico, Mexico, Apr. 5-9, 1919.

DISCUSSION.

In view of the large low-pressure area centered not far north at this time, it is possible that the wind which reached Tampico so hot and dry had been robbed of much of its moisture on passing up the west flank of the Mexican plateau, and then had been heated chiefly by compression on its eastward descent. The conditions observed at Tampico could have resulted if air nearly saturated at 50° F. had descended the 7,000 feet from the plateau to Tampico. In addition to the 37° F. rise in temperature which would have resulted from compression alone, it probably would have warmed 10° F. in passing over 60 or more miles of coastal plain during the morning. The fact that the three occurrences mentioned took place only during the middle of the day would seem to indicate that at other times, if there is a forced descent of air from the plateau, such heated air can not penetrate to the surface. The convectional mixing of the lower air strata, coupled with the diurnal warming of the air en route, seem to be necessary to make such foehn winds felt on the Gulf coast.—C. F. Brooks.

TORNADOES IN EASTERN NEBRASKA, APRIL 6, 1919.

By G. A. LOVELAND, Meteorologist.

[Dated: Weather Bureau, Lincoln, Nebr., May 22, 1919.]

An area of low pressure of unusual energy, 29.2 inches, was central in southwestern Nebraska or eastern Colorado on Sunday, April 6. (See fig. 1.) In the evening, three tornadoes occurred in eastern Nebraska. One of these was near Elmwood (25 miles SW. of Omaha) at 6 p. m. (90th meridian time). A second, near Madison (90 miles NNW. of Omaha) at 6:30 p. m. damaged 6 farms. A third occurred at Omaha at 7:30 p. m., and is said to have damaged 400 houses and caused a loss of a quarter of a million dollars.

The tornado near Elmwood was observed by a number of people, and the accompanying unusually good photographs (figs. 2 to 7) were made of it. The path of the tornado was narrow, most of the distance less than 300 feet in diameter, and it lay in a general direction a little west of north. At the same time, however, the upper portion of the funnel where it joined the general cloud base was moving toward a point a little east of north. The funnel increased in length, and finally an apparent

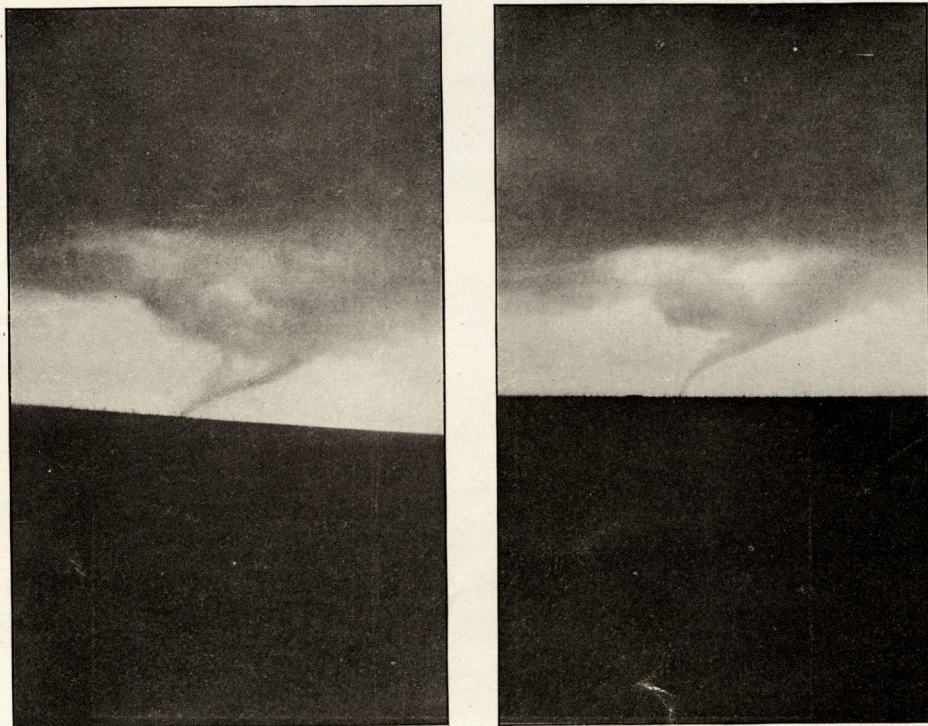
loop, due to perspective, developed. This loop shows somewhat in figures 2, 6, and 7. The funnel dissolved, but the dust cloud or lower portion of the funnel continued for a few seconds after the upper part had disappeared, and moved with devastating force for about three-fourths of a mile. The whole length of the tornado path was only about 7 miles, and the tornado made it in about 10 minutes. No lives were lost, but several farm houses were destroyed and others injured. Further details are given in the following extracts from observers' accounts.

Mr. W. A. Wood, of Weepingwater, Nebr., who took the photographs, figures 3 to 7, gives the following description of the local weather, and the appearance of the funnel cloud:

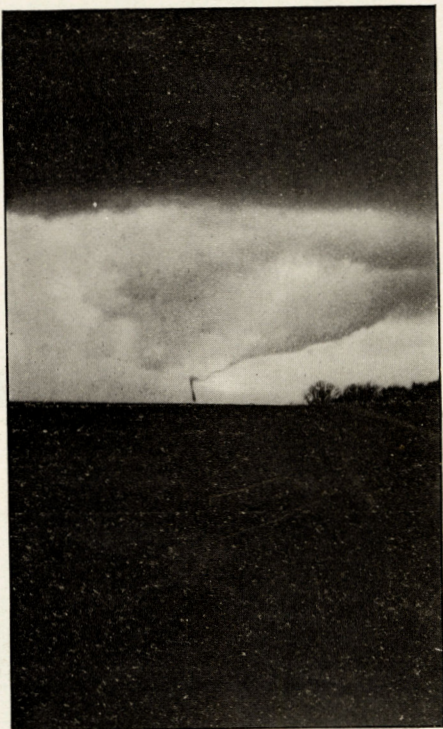
"Upon the day of the Elmwood tornado, I observed that there was every indication of rain, as the sky was entirely overcast with clouds and the weather was quite humid. About noon, however, the sky began to clear,



FIG. 2.—The tornado was photographed by G. B. Pickwell, who was very near its path. The upper picture, *a*, was the upper portion of the funnel, and was taken first. Immediately afterwards the lower portion of the funnel was photographed, and shows in *b*.



FIGS. 3 and 4.—Successive photographs of the tornado taken by W. A. Wood from the southeast.



FIGS. 5, 6, and 7.—Successive photographs of the tornado, taken by W. A. Wood from the southeast. In figures 6 and 7, note the vertically elongated form of the detached cumuli, which are characteristic of local convection intensified by a strong vertical temperature gradient. (See discussion.)

and in the afternoon we had every indication of continued good weather, were it not for the low pressure area in the southwest.

"Toward the latter part of the afternoon, storm clouds began to form, and in a short time it began to look like rain. At the base of what appeared to be a very ordinary cloud there was a small khaki-colored formation, that in a few moments began to taper, and which finally sent down a tiny line the color of blue smoke. This streamer made immediate connection with the earth and was the commencement of the tornado proper.

"This must have been a freak storm as the tail was very slender and resembled a rope dangling from the clouds. The pictures (figs. 3 to 7) tell the story better than I can write it.

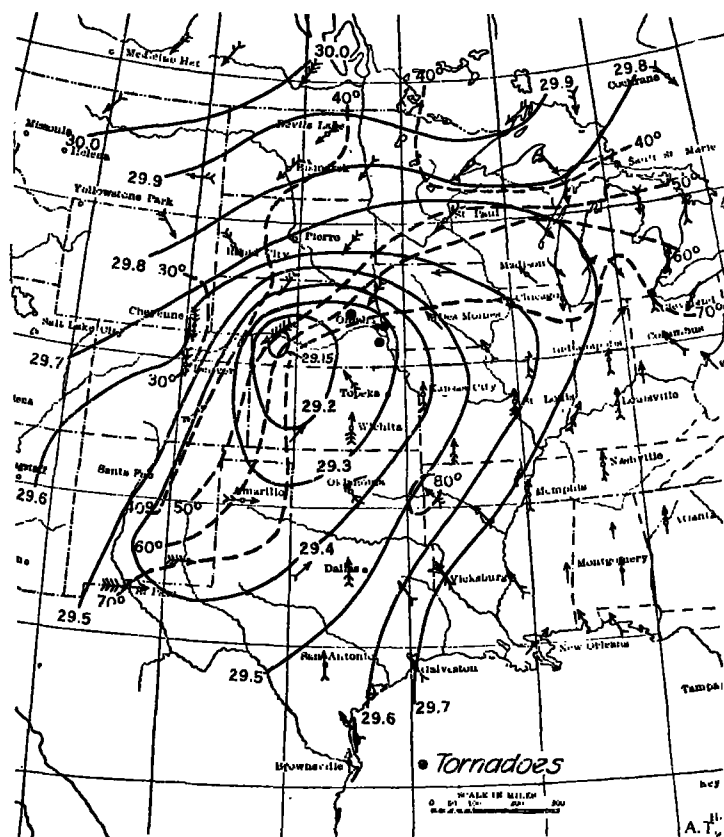


FIG. 1.—Weather map, Apr. 6, 1919, 7 p. m. (90th meridian time). The temperatures at North Platte, Neb., and Concordia, Kans., less than 200 miles apart, were 46° F. and 76° F., respectively. An extreme range of 54° F. occurred between Cheyenne, Wyo., temperature 26° F., and Fort Smith, Ark., temperature 80° F. The arrows fly with the wind, and the number of bars indicate the wind velocity in Beaufort numbers.

"It seems that the dissolution of the cloud was brought about from the fact that the progress of the lower part was slower than that of the upper, so that, finally, on being elongated to 1½ miles, it was pulled in two nearly at the center.

"The lower part continued for some time, peaked at the top. There was entirely blue sky beneath the main cloud, hence my advantage in taking the photos. Hail preceded the tornado."

Mr. W. A. Rocky, an instructor in the department of geography in the University of Nebraska, happened to be in the immediate vicinity of the tornado, and made some excellent observations of it. The following notes are from his detailed description.

"The Elmwood tornado * * * extended only for a distance of about 7 miles, from somewhere near the

west edge of sec. 9, T. 9 N., R. 10 E., 6 p. m., to the extreme southeastern corner sec. 6, T. 10 N., R. 10 E. For the first 4 miles of the course it traveled almost due north, with but little variation. In its last 3 miles it followed a course of about north 27° west. It took approximately 10 minutes to go 7 miles, a rate of 40 miles per hour. It was preceded by rain and hail, which was very heavy to the east of it, decreasing in amount to the westward. The storm did not greatly cool the atmosphere. Practically no rain fell more than half a mile west of the tornado track. There was no precipitation at all on the last mile of its course, either before or after its occurrence. The wind direction and velocity, about southeast 20 mis./hr. as nearly as could be observed, was constant during the entire hour of this storm. The tornado was accompanied by a very loud roaring and a sound of rushing air. * * *

"When first seen the base of the funnel was in the air, traveling like a kite's tail. Within 30 seconds it had reached the ground about 4 miles away. It was then in the southeast. It was observed from Elmwood for probably 6 minutes. * * *

"The funnel cloud during its entire existence appeared almost white, much as a column of steam. The sun's rays did not strike it at any time. Throughout its lower half it probably did not exceed 100 feet in diameter. The upper half of the funnel increased in size toward the top, and where it merged into the dark storm clouds above it probably had a diameter of 300 feet. As judged by the writer, the funnel had a length of from 1,000 to 1,500 feet, becoming longer toward the last. When first seen the cloud was inclined toward the north about 45° from vertical, the base dragging along in the air, and there was no dust cloud. The whirling of the cloud itself could be very clearly seen. Soon after the funnel struck the ground a cloud of dust and debris arose about 200 to 300 feet although the central core (white cloud) could be clearly seen through the dust envelope. * * * This outer cloud of dust was thickest near the ground, gradually thinning upward. The density and size of the dust cloud changed greatly, probably due to the varying looseness of the soil. About 300 feet above the ground no dust was seen at any time. Débris was seen flying in the upper, thinner portion of this dust cloud during the entire period of its existence. After the base of the funnel reached the ground the base appeared to increase its velocity, decreasing the angle of inclination of the funnel.

"During about the fourth mile of its course the funnel began to lean to the east as well as to the north, and by the end of its fifth mile the summit of the cloud was at an angle of about 45° from vertical, and northeast from the base of the cloud. During the last 2 miles of its course the base continued to veer westward, the funnel appearing to move more nearly northward, thus still further increasing the angle of inclination. During these last 3 miles the funnel gradually became more slender, and in several stages developed an apparent loop. This loop began in a very sharp, double curve or crook. It was always on the rear side of the advancing column and above the column, while the base trailed behind the summit but ahead of the loop. After the formation of this loop it slowly rose toward the summit of the cloud, which it reached at about the instant the cloud dissolved. During all of the final moments of the cloud the funnel was constantly decreasing in diameter. It is certain that toward the last some parts of the funnel near the base had a diameter not exceeding 25 feet.

"The dissolution of the funnel occupied a period estimated at not exceeding 10 seconds. Its disappearance was almost simultaneous from base to summit, much like the disappearance of steam when escaping into cooler air. * * * The surrounding rapidly revolving dust cloud continued on alone for a distance of three-fourths of a mile, apparently undiminished in size and velocity. It then crossed a draw probably 60 feet lower than the uplands, the whirling dust cloud suddenly broke, and, except for a straight cloud of dust, continuing for another fourth of a mile northwestward, there was no further evidence of a strong wind.

"The funnel cloud, which was at all times long and slender, appeared white as viewed by the writer (its western face). To Mr. Pickwell, who looked from the south and southwest, it appeared black near its summit, becoming lighter downward, with its base a very light gray. To Mr. W. A. Wood, 4 miles or more northeast from the cloud, it appeared dark its entire length. The outer surface of the funnel cloud was very clear cut near the base, becoming more fuzzy in appearance near the summit. The revolving of the funnel cloud could be very distinctly seen in all parts, certain sections sometimes having a fibrous or stringy appearance. The funnel appeared to lengthen or stretch very materially during the latter part of its course.

"During the progress of the cloud the large amount of material carried into the air from farmsteads just south of the Missouri Pacific Railway was distinctly seen. One building, apparently entire, was lifted about to the upper level of the dust cloud. While poised at that highest level all parts of the building appeared to come apart, flattened into a single horizontal plane, then scattered as a deck of cards thrown in the air. Trees were seen entire and broken. Parts of buildings were seen in the air at almost any moment during its course. The usual width of the devastated path was from 200 to 300 feet, and its borders were clearly marked. * * *

The following is a report of the Omaha tornado by Mr. M. V. Robins of the Weather Bureau.

"A small tornado that formed a short distance southwest of Omaha struck the city limits about 7:30 p. m. (90th meridian time), April 6, 1919, and moved in a north-northeasterly direction in the city over a path varying from 200 to 600 feet in width and between 3 and 4 miles in length. The funnel left the ground for short stretches, at places skipping blocks. After the tornado funnel had left the ground permanently, the wind was violent enough to do some damage even beyond the city limits north of Omaha as the storm moved on. The explosive effect was in evidence in a number of instances." * * *

"No loss of life occurred or has resulted from injuries received, but probably 20 persons received injuries, a few serious, but mostly they were slight. One house that contained eight people, three on the first floor and five in the basement, was completely demolished; but not one of the occupants was even scratched. Fortunately, the path of the tornado was through a district part of which was not thickly settled, hence the comparatively small property loss (about \$250,000) and few casualties.

"Some observers said that there was a violent commotion among the very dark coppery clouds in the southwest just before the funnel appeared; others that the storm cloud which swept the earth was more like a pillar than a funnel, and a few reported that tongues of lightning flashed from its center. I was on my way home from the car line, and it later developed in the immediate path of the storm, when I heard the unmistakable roar as of a great engine, and saw the dark mass rushing in my direction. I ran for home hoping to reach it in time to get my family into the basement, but by the time I arrived the storm had passed a few hundred feet to the east. At my location there were violent gusts, and even at greater distances from the storm path windows were blown out and slight damage was done to shingle roofs. To me the cloud looked more like a pillar than a funnel, but on the west side a dirty brown whirl was clearly visible in the flashes of lightning. During the passing of the tornado light hail fell, and there was light rain for about an hour before the storm struck, the latter ending at 7:55 p. m. Later, about 11 p. m., rain fell at an excessive rate, doing considerable damage to wrecked homes and unprotected furniture, etc.

"The debris was strewn in all directions, but the greater portion lay in the general direction of the forward movement of the storm.

"A strange coincidence is that this tornado entered the city but a short distance from the point of entrance of the one of Easter Sunday, March 23, 1913, but the latter took a direction that was almost due northeast and its path of destruction was much more complete and larger."

DISCUSSION.

These unusual tornadoes seem to have what might be called true vortices caused by thermally unstable air. There was no general cloudiness such as marks a turbulent wind-shift line in which the direct mechanical action of grazing winds of opposite directions and densities might cause tornadic whirls. There seems to have been, instead, a steep temperature gradient not far aloft, such as would greatly intensify the vertical movement of the warm, convectional currents from the surface, which must have arisen from the sun's heating during the fair afternoon. The markedly elongated form of the cumulus clouds seen in the background of some of the pictures is indicative of such strong local convection which has become intense since condensation is retarding the cooling of the rising air.

The cold air necessary to have formed such a strong gradient aloft probably came from the very cold side. Over this region this cold wind was probably westerly, as the intermediate and upper clouds in the morning were moving from the west. The surface SE. wind would explain the movement of the lower part of the tornado, and the W. cold wind aloft would explain the rapid northeastward movement of the parent cloud and the fall of rain and hail generally east of the track.

—C. F. Brooks.